Variations of population structure and important value of the main edificators along the elevation gradient on the northern slope of Changbai Mountain

JIANG Ping[1,2], YE Ji[2], DENG Hong-bing[3], CUI GUO-fa[1]

[1] *Beijing Forestry University, Beijing* 100083, *P. R. China*

[2] *Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang* 110016, *P. R. China*

[3] *Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing* 100085, *P. R. China*

Abstract: From 700 m to 1900 m on the northern slope of Changbai Mountain, 13 plots with an interval of 100 m in elevation were investigated to study the variations of population structure and important value of the main edificators along the elevation gradient. In their core distribution areas, most of the edificators had healthy population structure and could regenerate smoothly except *Larix olgensis*, but important value of *Larix olgensis* had no obvious variations with elevation changes, which showed that *Larix olgensis* had its own particularity and strong adaptability. At high elevation above 1800 m, *Betula ermanii* was the only species that could form a mono-dominant community. Important values of *Pinus koraiensis* and *Acer mono* had similar changing trends, and they had the similar ecological adaptabilities.

Keywords: Edificator; Population; Important value; Structure; Elevation gradient; Changbai Mountain

CLC number: S718.54 **Document code:** A **Article ID:** 1007-662X(2003)02-0117-05

Introduction

Plant community is a long-term process of the plant complex formation and development in a long-history process, and it is related closely to the environments (Hao *et al.* 2002). Plant community is composed of different plant populations, so, studying plant populations is one of the bases of plant community ecology (Deng *et al.* 2000). In a plant community, the species that controls energy flow and the material cycle effectively and has obvious the most apparent effects on community composition and community environment formation is called the dominant species (Magurran 1988). Each different layer of community has own dominant species, and the dominant species in dominant layer is edificator (Sun *et al.* 1993). Commonly abundance and coverage of the edificator is over 80% (Wang *et al.* 1996).

There exists an obvious environmental gradient on the north slope of Changbai Mountain, and species compositions vary along the altitude gradient (Wang *et al.* 1980; Chen *et al.* 1964; Zhao 1980). The present research dealt with the variations of population structure and important value of main edificators along the elevation gradient, and its results could reflect the status and functions of the edificators in the plant communities and reveal the distribution patterns of the edificators along elevation gradients.

Study area and methods

Study area

The study was conducted between the altitudes of 700 m to 1900 m on northern slope of Changbai Mountain with a horizontal distance of 40 km. The annual temperature in the area of elevation of 700 m averages 2.8 °C and it belongs to the typical warm temperate zone. At the elevation of 1900 m, the annual average temperature is -3.3 °C and it belongs to the sub-alpine climate (Chi *et al.* 1981; Zhang *et al.* 1984). Along the elevation gradient, there exist different vegetation types: broad-leaved /Korean pine forest (elevation lower than 1100 m), dark coniferous forest (from 1100 m to 1800 m), and sub-alpine *Betula ermanii* forest (from 1800 m to 2000 m), (Wang *et al.* 1980; Zhao 1980). Climate factors along the slope were shown in Table 1 (Chi *et al.* 1981).

Sampling and investigation

The sampling plots were set by gradient pattern. From the altitudes of 700 m to 1900 m, 13 plots (1024 m^2) of 32 m×32 m with an at intervals of 100 m in elevation were set. Basic character such as altitude, slope degree and coverage of the plot was first investigated, and then a sketch of the plot was drawn. In each plot, tree species, diameter at breast height (DBH), incremental state (withering or normal) and tree height were measured. According to diameter and height of trees, three groups: overstorey (overstorey, DBH≥8 cm), successional layer (sapling, DBH<8 cm), re-

Foundation item: This research was supported by Chinese Academy of Sciences "100 people" project, National Natural Science Foundation of China (39970123), and Changbai Mountain Open Research Station.

Biography: JIANG Ping (1965-), female, Assistant Research Fellow in Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang 110016, P. R. China (E-mail: digitalp@iae.ac.cn).

Received date: 2003-03-11

Responsible editor: Zhu Hong

newal layer (seedling, height <1.3 m, no DBH) were classified

Data analysis

EXCEL software was used for data processing. Important value could be calculated by equations as follows (Wang *et al.* 1996):

$$R_{Ai} = \frac{I_{Qi}}{\sum I_{Qi}} \tag{1}$$

$$R_{Fi} = \frac{P_{Qi}}{\sum B_{Hi}} \tag{2}$$

$$R_{Di} = \frac{B_{HAi}}{\sum B_{HAi}} \tag{3}$$

$$I_{Vi} = \frac{R_{Ai} + R_{Fi} + R_{Di}}{3} \tag{4}$$

where, R_{Ai} means relative abundance of species i; R_{Fi} means relative frequency of species i; R_{Di} means relative dominance of species i; I_{Qi} means individual quantity of species i; P_{Qi} means plot quantity of species i; B_{HAi} means breast height area of species i; and I_{Vi} means important value of species i.

Results and analysis

Population structure

Fig. 1 showed population structures of some edificators at different elevations. From Fig. 1, it was known that some edificator populations such as *Abies nephrolepis* and *Picea jezoensis* var. *komarovii* had a normal population distribution of individual quantity at each elevation, and especially in their core distribution area (1200-1700 m), their distribution frequencies approached 100%. There were quite abundant individuals of these edificators in the main forest layer, succession layer, and generation layer, and this showed that they had a healthy developmental population structure.

For *Larix olgensis*, there were mainly old big trees of a mono-generation, and at each elevation, they accounted for a certain percentage in the main forest layer, but in succession layer and regeneration layer, there were few individuals of *Larix olgensis*. This showed that *Larix olgensis* could not regenerate normally at elevation of 800-1800 m and was a declining population.

Only in the core distribution area under an elevation of 1200 m, seedlings of *Pinus koraiensis* were able to grow into the main forest layer and the regeneration could be realized. At elevation of 1300-1400 m, although there were relatively abundant seedlings, the seedlings could not grow and develop normally into the main forest layer. Above 1800 m, there were few trees and seedlings of *Pinus koraiensis*.

Betula ermanii is high-elevation species, but its frequency and quantity in the core distribution area were lower than those out of the core distribution area. Other edificators such as *Tilia amurensis*, *Fraxinus mandshurica*, and *Acer mono* had their healthy population structures only under an elevation of 1000 m. Their regeneration quantities were not large, but other qualities were well.

Important value

Fig. 2 shows the variation of important values of main species along the elevation gradient. From an elevation of 700 m, the important value of *Abies nephrolepis* gradually increased with elevation increasing, and reached the maximum value of 30% at an elevation of 1400 m, and then it began to gradually decrease. Important value of *Picea jezoensis* var. *komarovii* increased gradually from 700 m to 1600 m, too. *Abies nephrolepis* and *Picea jezoensis* var. *komarovii* played important roles in the whole plant belt, and at most elevations, their important values were over 20%.

Table 1. Variation of climate factors along the elevation on the northern slope of Changbai Mountain

Ele. /m	Ann. Ave. Tem. /°C	Ann. Ave. Prec. /mm	Ann. accum. Tem. > 5°C /°C	Ave. Prev. of Jun.-Sep. /mm	Index of aridity	Index of humidity	Jan Ave. Tem /°C	July Ave. Tem /°C	Period of no frost/d	Period of snow /d
700	2.83	679.18	2459.77	483.02	0.67	1.91	-17.33	19.63	121.00	130.79
800	2.32	703.62	2285.25	500.40	0.63	2.21	-17.64	19.07	116.54	137.58
900	1.81	728.95	2123.12	518.41	0.59	2.52	-17.95	18.51	112.25	144.37
1000	1.29	755.19	1972.49	537.07	0.56	2.82	-18.27	17.95	108.12	151.16
1100	0.78	782.37	1832.55	556.40	0.53	3.12	-18.58	17.40	104.14	157.94
1200	0.27	810.53	1702.53	576.43	0.50	3.43	-18.89	16.84	100.31	164.73
1300	-0.24	839.70	1581.74	597.18	0.47	3.73	-19.21	16.28	96.62	171.52
1400	-0.75	869.92	1469.52	618.67	0.44	4.04	-19.52	15.73	93.06	178.31
1500	-1.26	901.23	1365.26	640.94	0.42	4.34	-19.83	15.17	89.64	185.10
1600	-1.78	933.67	1268.40	664.01	0.39	4.65	-20.15	14.61	86.34	191.88
1700	-2.29	967.28	1178.41	687.91	0.37	4.95	-20.46	14.06	83.16	198.67
1800	-2.80	1002.09	1094.81	712.67	0.35	5.26	-20.77	13.50	80.10	205.46
1900	-3.31	1038.16	1017.13	738.32	0.33	5.56	-21.09	12.94	77.15	212.25

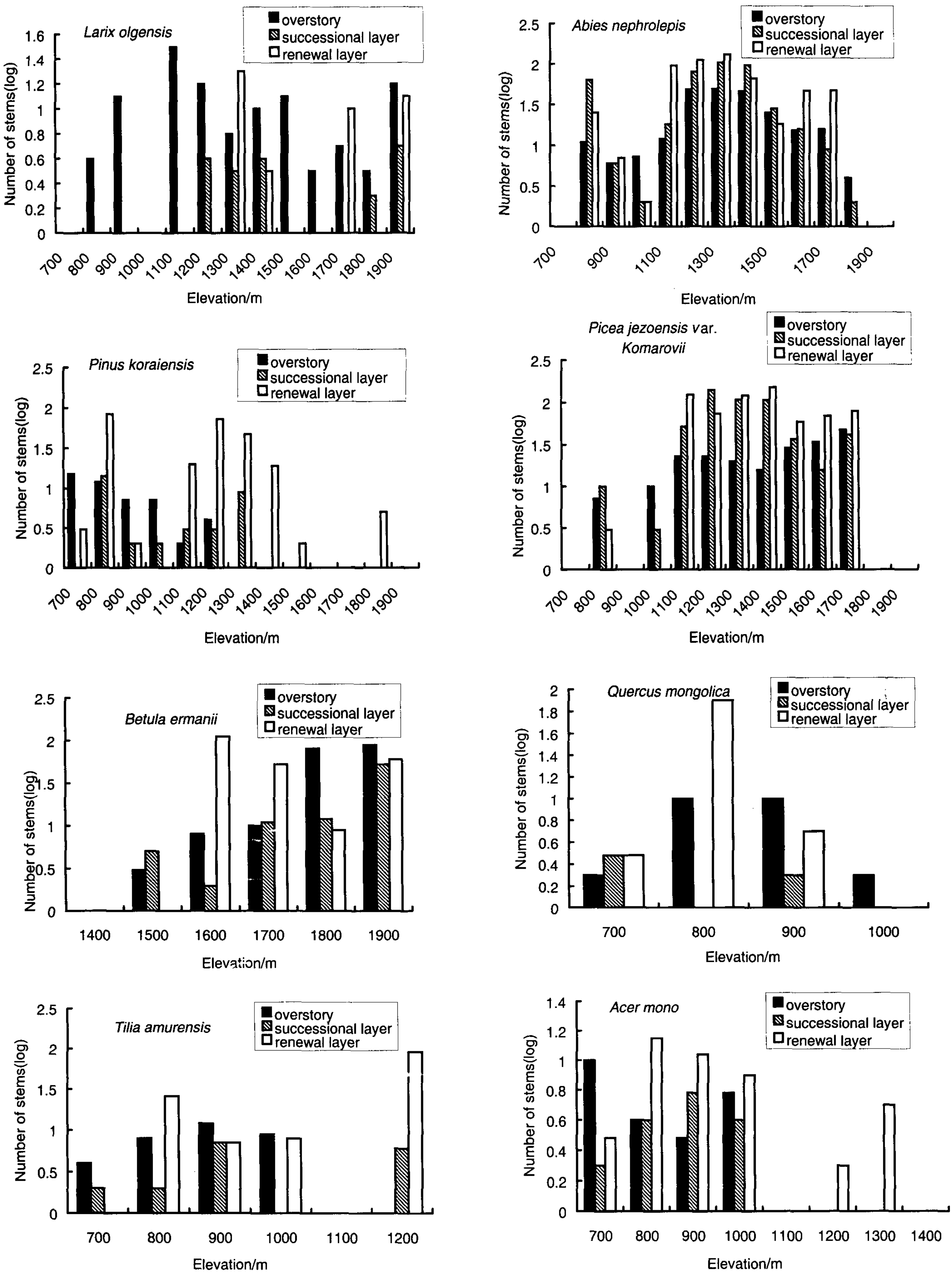

Fig. 1 Population structure of edificators at different elevations

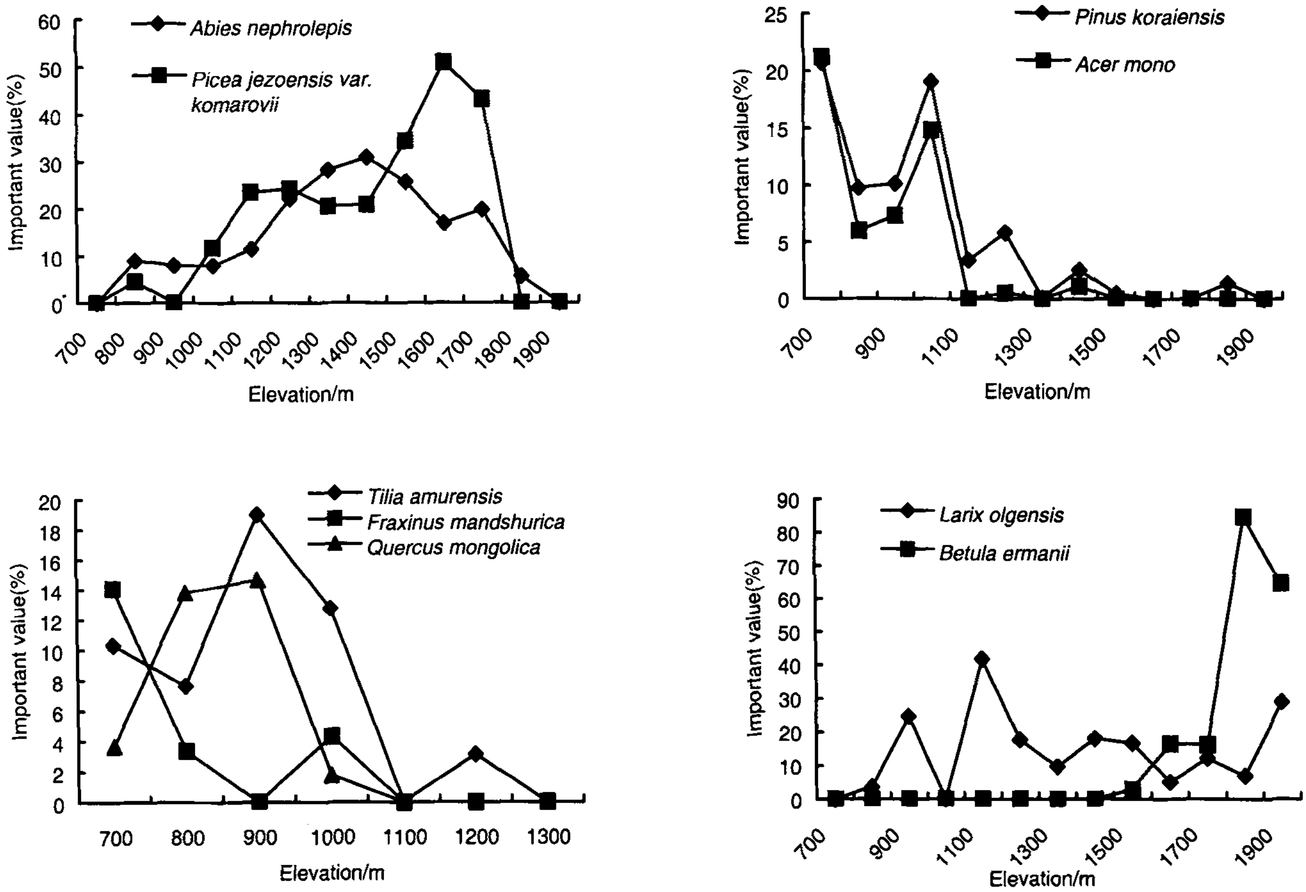

Fig. 2 Variation of important values of the main edificators along elevation gradient

Important values of *Pinus koraiensis* and *Acer mono* had a similar trend, and in corresponding communities, their important values were very similar, which showed that they had similar ecological adaptabilities.

Important values of *Quercus mongolica* and *Tilia amurensis* were from 10% to 20% at elevations below 1000 m, and this showed that they had higher importance value. Above 1000 m, their important values were very low, and above 1200 m, their important values were zero. *Fraxinus mandshurica* had high important value only at 700 m, and the important value descended gradually with increasing elevation, and was zero above 1100 m.

Important value of *Larix olgensis* had no obvious variations with elevation changing. From low elevation to forest line, important value of *Larix olgensis* was mostly about 20%. This adequately showed the particularity and strong adaptability of *Larix olgensis.*

Betula ermanii entered into the main forest layer above 1500 m. The important value of *Larix olgensis* increased with elevation, and reached to 80% at elevation of 1800 m. So, *Betula ermanii* was the only species that could form a mono-dominant community.

Conclusions and discussion

Although there were lots of studies on plant communities on northern slope of Changbai Mountain, there were few studies about the variations along elevation gradient and considered the communities synthetically (Hao *et al.* 2002). In recent years, some relative studies turned their focus to the variations along elevation gradient, and they had important effects in completing the relative researches (Deng *et al.* 2000; Hao *et al.* 2002). In their core distribution areas, most of the edificators had healthy population structure and could regenerate smoothly except *Larix olgensis*, but the important value of *Larix olgensis* had no obvious variations with elevation changing, which showed that *Larix olgensis* had its own particularity and strong adaptability.

Although there existed different vegetation belts on northern slope of Changbai Mountain, *Abies nephrolepis* and *Picea jezoensis* var. *komarovii* played the important roles in the whole belt, and at most elevations, their important values were over 20%. So, *Abies nephrolepis* and *Picea jezoensis* var. *komarovii* were important edificators in most of the belts except elevation higher than 1600. Furthermore, at high elevation above 1800 m, *Betula ermanii* was only species that could form mono-dominant community.

Important values of *Pinus koraiensis* and *Acer mono* had similar trends, and in corresponding communities, their important values were very close, which showed that they had similar ecological adaptabilities. As two different spe-

cies, *Pinus koraiensis* and *Acer mono* have some similarities in environmental requirements, and this phenomenon is worthy to study and deep discussion.

References

Chen Lingzhi, Bao Xiancheng. 1964. Some structural characteristics of main plant communities in different vertical zones on the Northern slope of the Changbai Mountain in Jilin Province [J]. Acta Phytoecologica et Geobotanica Sinica, **2**(2): 207-225.

Chi Zhenwen, Zhang Fengshan, Li Xiaoyan, *et al.* 1981. Initial research on water and hot conditions of main forest vegetation types on the northern slope of the Changbai Mountain [C]. In: Forest Ecosystem Research (2). Beijing: China Forestry Publishing House, 179-186.

Deng Hongbing, Hao zhanqing, Jiang Ping, *et al.* 2000. Species frequency of communities along northern slope of Changbai Mountain, Northeast China [J]. Journal of Forestry Research, **11**(3): 187-190.

Hao zhanqing, Yu Deyong, Deng Hongbing, *et al.* 2002. Study on complexity of plant communities at different altitudes on northern slope of Changbai Mountain [J]. Journal of Forestry Research, **13**(1): 17-20.

Magurran, A.E. 1988. Ecological diversity and its measurement [M]. New Jersy: Princeton University Press, 56-80.

Sun Ruyong, Li Bo, Zhu Geyang, *et al.* 1993. General Ecology [M]. Beijing: Higher-Education Publishing Company, 128-135.

Wang Bosong, Yu Shixiao and Peng Shaoling. 1996. Handbook for plant community experiment [M]. Guangzhou: Guangdong higher Education Press, 110-131.

Wang Zhan, Xu Zhenbang, Li Xin, *et al.* 1980. Main forest types and characteristics of community structure on the northern slope of the Changbai Mountain [C]. In: Forest Ecosystem Research (1). Beijing: China Forestry Publishing House, 25-42.

Zhang Fengshan and Li Xiaoyan. 1984. Temperature and humidity characteristics of main forest types in growing period on the northern slope of the Changbai Mountain [C]. In: Forest Ecosystem Research (4). Beijing: China Forestry Publishing House, 243-254.

Zhao Dachang. 1980. Vertical distribution zone of vegetation of the Changbai Mountain [C]. In: Forest Ecosystem Research (1). Beijing: China Forestry Publishing House, 65-70.